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ATTACHMENT TO:



EXRAND-M-41

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OPTICAL POWER SPECTRUM BRIEFING



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The briefing reported the results of an R&D contract with []
[] to study the Optical Power Spectrum as a measure of image
quality.

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The primary objective of the Optical Power Spectrum project was to obtain a reliable, rapid, and automated technique for measuring the quality of operational imagery. In addition, the technique was to apply to imagery (negative or positive) of all acquisition systems, provide for changes of scale and target, correlate well with quality judgments made by the PI, and be suitable for use throughout the intelligence community. These objectives have been met.

The Optical Power Spectrum measurements are made on electro-optical equipment designed originally for the ATR/cloud detection portion of the [] contract. The image quality clue extraction algorithms developed are based on the hypothesis that the spatial frequency content of a given image is related to the quality of that image as judged by professional PI's.

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Three sets of imagery were used to test the validity of the OPS technique; each had been previously evaluated by NPIC personnel in other experiments. Set A included the eight MIP reference operational scale (1:200,000) currently in use in APSD. The OPS measurements ranked these images as follows: 110, 115, 105, 100, 95, 90, 85, 80. The reversal of #110 and #115 was real and not an artifact of a particular measurement. When presented to the APSD staff they acknowledged that some of their observers had also ranked them in the reversed order and that the OPS was probably correct.

Set B included 32 relatively low quality, non-operational aerial images. The target was an industrial area; the resolution, MTF, grain noise, and contrast of the image had been varied in a known and controlled manner. These images too had been ranked by PI's. The correlation of the OPS measurements with these judgements was 0.88, a very high result.

Set C included 32 images on negative material (3404), 1:40,000 scale each varying in focus by 0.005" of the focal length. The OPS measurement selected the same best focus frame as that determined by human observers.

It was concluded that the OPS can serve as a relative measure of photographic image quality which correlates very well with quality estimates made by professional PI's. It allows automatically for

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scale changes equally well with negative or positive imagery; it does not require special targets or the presence of straight edges, and does not appear to be system limited.

Its measurement is relatively simple to make but does require special equipment and can be accomplished on or off-line as time permits.

The OPS may provide a means of quantifying image quality in terms of information content and interpreter performance. This aspect requires further research.

NPIC intends to conduct further experiments with a larger sample of imagery from all acquisition systems and optimize image quality clues.

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